(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 904 741 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
31.03.1999 Bulletin 1999/13

(51) Int Cl.[6] A61B 19/00, A61B 17/00

(21) Application number: 98306494.0

(22) Date of filing: 14.08.1998

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 26.09.1997 US 60103 P

(71) Applicant: PICKER INTERNATIONAL, INC.
Cleveland, Ohio 44143 (US)

(72) Inventors:
- Stern, Benjamin
Willoughby Hills, Ohio 44094 (US)
- Molyneaux, David
Mentor, Ohio 44060 (US)
- Lampman, David
Eastlake, Ohio 44095 (US)

(74) Representative: Waters, Jeffrey
GEC PATENT DEPARTMENT,
Waterhouse Lane
Chelmsford, Essex CM1 2QX (GB)

# (54) Apparatus for supporting a surgical instrument

(57) An apparatus (1) for supporting a surgical instrument in the operative environment of an imaging device comprises components all made of a material compatible for use in the operative environment of the imaging device. The components of the apparatus (1), made of such a material, include a member (32) that has a spherical surface and includes a bore (50) extending through the member along its diameter. A grip (26) has a grip surface defining an aperture that is adapted to receive the member for rotatable movement within the aperture. The grip (26) extends around the member (32) in a circumferential path and has a gap therein. A fastener (30) is operatively connected to the grip (26). The fastener (30) is adjustable to change the size of the gap and adjust the compressive force applied to the received member (32) in the grip.

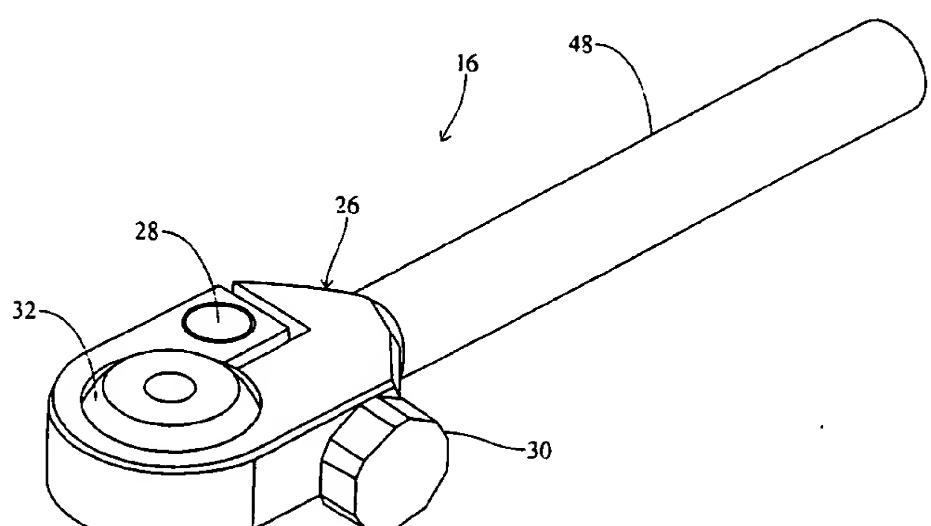


Fig. 2

EP 0 904 741 A2

tive device is that the likelihood of inadvertent connections or short circuits between electrical devices in the area is increased. As a result, the Greenberg and Bookwalter clamps are not suitable for use in MR-guided or MR-assisted surgical procedures.

[0010] As an alternative to stainless steel, positioning devices have been fabricated from titanium. For example, Bookwalter clamps for interventional MR use have also been fabricated from titanium. While devices fabricated from titanium are not affected by the magnetic fields of the MR scanner and are therefore MR-safe, they are not MR-compatible. Titanium devices also do not address the issues noted above in regard to electrical conductivity. Another disadvantage of devices fabricated from titanium is their high cost.

[0011] The present invention is directed to a support apparatus that satisfies the need to provide a surgical guide which is (i) MR-safe and MR-compatible and/or (ii) X-Ray/CT transparent in the operative environment of an imaging device. The support apparatus allows the trajectory of the surgical tool be readily adjusted while providing stable and accurate guidance for use with a variety of surgical tools. A support apparatus having the features of the present invention comprises means for supporting the surgical instrument. The support means is adapted to position the surgical instrument along a desired trajectory and is made of material compatible for use in the operative environment of the imaging device. A means for securing the position and trajectory of the surgical instrument operatively engages the support means and is also made of material compatible for use in the operative environment of the imaging device.

[0012] In accordance with a more limited aspect of the present invention, the apparatus includes a first member having a first aperture extending through guide member. The first aperture is adapted to receive the surgical instrument. A second member has a second aperture and is adapted to receive the surgical instrument. The relative position of the first and second members is selectively adjustable to vary the relative positions of the first and second apertures thereby securing the surgical instrument.

[0013] In accordance with a more limited aspect of the present invention, the first member has a circular counterbore eccentrically located with respect to the first aperture. The second member is adapted to be rotatably received in the counterbore. The second aperture is located eccentrically with respect to the counterbore when the second member is received in the counterbore.

[0014] In a more limited aspect of the present invention, the material compatible for use in the operative environment of the imaging device is a polymer material and in a more limited aspect, the polymer material is polycarbonate, polyetherimide, polyacetal, polyphenylsulfone or polyarylethersulfone.

[0015] In accordance with another limited aspect of the invention, the support means includes a plurality of markers placed at known locations with respect thereto The markers are adapted to provide signals indicative of their position in the operative environment of the imaging device.

[0016] In accordance with another aspect of the present invention, an apparatus for securing an instrument in a support assembly comprises a first member having a first aperture adapted to receive the instrument. A second member has a second aperture extending therethrough and is adapted to receive the instrument. The relative position of the first and second members is selectively adjustable to vary the relative positions of the first and second apertures thereby securing the surgical instrument.

[0017] In accordance with another aspect of the present invention an apparatus for positioning a surgical instrument in the operative environment of an MR imaging system comprises a surgical instrument guide adapted to receive and position the surgical instrument. A magnetic resonance RF coil is mounted to the surgical instrument guide.

[0018] In accordance with a more limited aspect of the invention, the surgical instrument guide is made of material compatible for use in the operative environment of the MR imaging system.

[0019] In accordance with yet another more limited aspect of the invention the RF coil is adapted to allow the surgical instrument to pass through the RF coil.

[0020] In accordance with another aspect of the invention, an apparatus for supporting a surgical instrument in the operative environment of an imaging device comprises a member made of polymer material having spherical surface including a bore extending through the member along its diameter. A grip made of polymer material is included that has a grip surface defining an aperture adapted to receive the member for rotatable movement within the aperture. The grip extends around the member in a circumferential path and has a gap in the circumferential path. A fastener made of polymer material is operatively connected to the grip and is adjustable to change the size of the gap thereby adjusting the compressive force applied to the received member in the grip.

[0021] In accordance with a more limited aspect of the invention, the grip surface includes two axially spaced apart annular side segments, each of the side segments having an inner surface. The inner surface of each side segment is located a respective radius from the centre of the grip aperture. The side segments are spaced apart by a central segment that has an inner surface located at a radius from the grip centre greater than the side segments. Each of the side segments have an inner lip that contacts the received member.

[0022] In accordance with a more limited aspect of the present invention each of the components can be made of different polymer material than any of the other components.

[0023] Ways of carrying out the invention will now be described in detail, by way of example, with reference

ably attached is readily removable from the needle guide 56

[0032] The locking collar 70 includes a locking aperture 74 which is eccentric to the insert portion, preferably by approximately one-tenth the diameter of the locking aperture 74. Thus, for a locking aperture 74 having a diameter of 1.95 mm, the locking aperture 74 is eccentric by 0.2 mm. The upper end 76 of the locking collar 70 has a diameter larger than that of the insert portion 72 and defines a shoulder 78. A notch 80 defines the direction of eccentricity.

[0033] Other inserts are also contemplated. For example, a wand collar is adapted to receive a surgical device such as a probe or wand used in connection with an image guided surgery system. The wand collar is similar to the to the needle collar 56 shown in Figures 7a, 7b, and 7c, although the guide aperture 60 sized to accept the desired probe. Similarly, collars adapted to receive other surgical tools, such as Kelly coagulators, drills, drill sheaths, and the like may readily be implemented. These collars may also be used with an appropriate locking collars, with the locking aperture configured to accept the desired tool. In a preferred embodiment, however, collars for use with surgical wands and Kelly coagulators are not eccentric as described above.

[0034] While the guide apertures have been described as having a circular cross-sections, other cross sections may also be implemented, for example where it is desirable to retain a tool having a particular rotational sense. In this way, rotation of the tool within the guide aperture may be prevented. The apparatus may also be used in connection with tools for retracting tissue, such as brain spatulas. While the direction of eccentricity has been described as indicated by notches 69, 80, it will be appreciated the indication can be made by other means, for example markings, grooves, protrusions, geometrically distinct features, or the like.

[0035] The guide apparatus 1 is preferably fabricated from materials such as polymers which demonstrate the desired MR-safety and MR-compatibility and/or X-Ray/CT compatible while providing the necessary physical properties. In a preferred embodiment for MR imaging modalities, the post 12 and rod clamp 14 are fabricated from 30% glass filled polycarbonate, for example as marketed under the trade name Ultem 2300 G.E. Plastics of Pittsfield, Massachusetts. Another suitable material is marketed under the trade name Zelux M-GF30 by Westlake Plastics of Lennie, Pennsylvania. An embodiment that is also X-Ray/CT compatible is fabricated without glass filling and may be made of the same material as the grip 26 and pivot ball 32 which are fabricated from polyetherimide, for example as marketed under the trade name Ultem 1000 by G.E. Plastics of Pittsfield, Massachusetts. The hand screw 30 and barrel nut 28 are preferably fabricated from polyphenylsulfone, also known as polyarylethersulfone, for example as marketed under the trademark Radel R by Amoco Performance Products of Atlanta, Georgia. Another suitable material is polyacetal, for example as marketed under the trade name Delrin by E I DuPont of Wilmington, Delaware. The various insert collars are preferably fabricated from polyphenylsulfone marketed under the trademark Radel R described above.

[0036] Other materials having suitable physical properties, particularly relatively high strength and stiffness, biocompatibility, and ease of sterilization, may be substituted. The materials used for the grip 26 and pivot ball 32 preferably have relatively high coefficients of friction, whereas the materials used for the hand screw 30 and barrel nut 28 have relatively low frictional coefficients. The guide apparatus 1 may also be fabricated from materials selected for their transparency to x-radiation where it desirable to use the apparatus 1 in connection with equipment such as CT scanners, radiographic equipment, or fluoroscopic equipment.

[0037] In operation, the post 12 of the guide apparatus 1 is screwed into a suitable structure, for example the bed of an MR scanner or other imaging device or a stationary scanner portion. The surgeon selects an appropriate collar, for example the wand collar described above. The collar is inserted into the pivot aperture 50 and tightened such that the threads on the collar engage the threads 54 in the pivot aperture and the shoulder 66 of the collar 56 is seated on the second surface 52b of the pivot ball 32. Thus, the collar is held firmly in place with respect to the pivot ball 32.

[0038] With the hand screw 30 loosened, the pivot ball 32 is freely rotatable in relation to the grip 26. The surgeon inserts a tool, such as a probe which is trackable by the image guided surgery system, into the guide aperture of the collar. The orientation of the tool is then adjusted, for example, by placing the tip of the probe on the surface of the patient and adjusting the position and orientation of the probe until a desired trajectory is achieved. Of course, the position of the guide assembly 16 in relation to the patient may be adjusted as necessary using the rod clamp 14.

[0039] When the tool has been properly oriented, the hand screw 30 is tightened. The resultant compressive force acts across the gap 42 to reduce the diameter of the grip aperture 34. The inner edges of the lips 36, 38 engage the pivot ball 32 along substantially their entire circumference and further apply compressive forces on the pivot ball 32. As a result, only a small amount of torque on the hand screw 30 is sufficient to create a large clamping force on the pivot ball 32. Thus, the pivot ball 32 and hence the guide axis and tool are held firmly in place. Of course, the trajectory of the probe may be re-adjusted as necessary.

[0040] With the tool guide assembly 16 and the pivot ball 32 fixed in place, the guide apparatus may be used to guide the application of various tools in respect to the anatomy of the patient. For example, the first tool may be removed from the guide aperture and replaced with an alternate tool such as a drill sheath and an associated surgical drill. Again, however, the trajectory of the tools

obtrusive easy to use and usable with a variety of surgical tools.

**[0052]** One advantage of the present invention is that the instrument support device is both safe and compatible for use in the operative environment of an imaging device thereby allowing interventional surgical procedures to be carried out without affecting the image provided by the device.

**[0053]** Another advantage of the present invention is that it securely locks the surgical instrument within the support member without deforming the instrument.

**[0054]** Yet a further advantage of the present invention is that the support member is easily and more securely locked in the desired position.

**[0055]** While a particular feature of the invention may have been described above with respect to only one of the illustrated embodiments, such features may be combined with one or more other features of other embodiments, as may be desired and advantageous for any given particular application.

**[0056]** From the above description of the invention, those skilled in the art will perceive improvements, changes and modification. Such improvements, changes and modification within the skill of the art are intended to be covered by the appended claims.

## Claims

1. Apparatus for supporting a surgical instrument in the operative environment of an imaging device, the apparatus comprising: means (32) for supporting the surgical instrument in a desired position along a desired trajectory, the means for supporting made of material compatible for use in the operative environment of the imaging device; and means (26) for securing the means for supporting, the means for securing made of material compatible for use in the operative environment of the imaging device.

2. Apparatus as claimed in claim 1, wherein the means for supporting includes a first member (56) having a first aperture (60) extending therethrough adapted to receive the surgical instrument; and a second member (70) having a second aperture (74) extending therethrough, the second aperture adapted to receive the surgical instrument, the relative positions of the first and second members being selectively adjustable to vary the relative position of the first and second apertures thereby securing the surgical instrument.

3. Apparatus as claimed in claim 2, wherein the surgical instrument is a biopsy needle and the first and second apertures are adapted to receive the biopsy needle.

4. Apparatus as claimed in claim 2 or claim 3, wherein the first member (56) has a circular counterbore (68) at one end of the first aperture (60), the counterbore is eccentrically located with respect to the first aperture, and the second member (70) being adapted to be rotatably received in the counterbore of the first member, the second aperture (74) located eccentrically with respect to the counterbore when the second member is received therein.

5. Apparatus as claimed in any one of claims 1 to 4, wherein the material compatible for use in the operative environment of the imaging device is a polymer material.

6. Apparatus as claimed in claim 5, wherein the polymer material is polycarbonate, polyetherimide, polyacetal, polyphenylsulfone or polyarylethersulfone.

7. Apparatus as claimed in any one of claims 1 to 6, wherein the means for supporting includes a plurality of markers placed at known locations with respect thereto, the markers being adapted to provide signals indicative of their position in the operative environment of the imaging device.

8. Apparatus as claimed in any one of claims 1 to 7, including a magnetic resonance RF coil (86) mounted to at least one of the means for supporting or means for securing.

9. Apparatus as claimed in claim 8, wherein the RF coil is adapted to allow the surgical instrument received in the means for supporting to pass through the RF coil.

10. Apparatus as claimed in any one of claims 1 to 9, wherein the means for supporting includes a member (32) having a spherical surface and a bore (50) extending through the member along its diameter, and the means for securing includes a grip (26) made of polymer material having a grip surface defining an aperture (34) adapted to receive the member for movement within the aperture, the grip extending around the member in a circumferential path, the grip having a gap (42) in the circumferential path, the means for securing further including a fastener (28, 30) made of polymer material operatively connected to the grip, the fastener adapted to change the size of the gap and adjust the compressive force applied to the received member in the grip.

11. Apparatus as claimed in claim 10, wherein the grip surface includes two axially spaced apart annular side segments (36, 38), each of the side segments having an associated inner surface, the inner surface of each side segment located a respective ra-

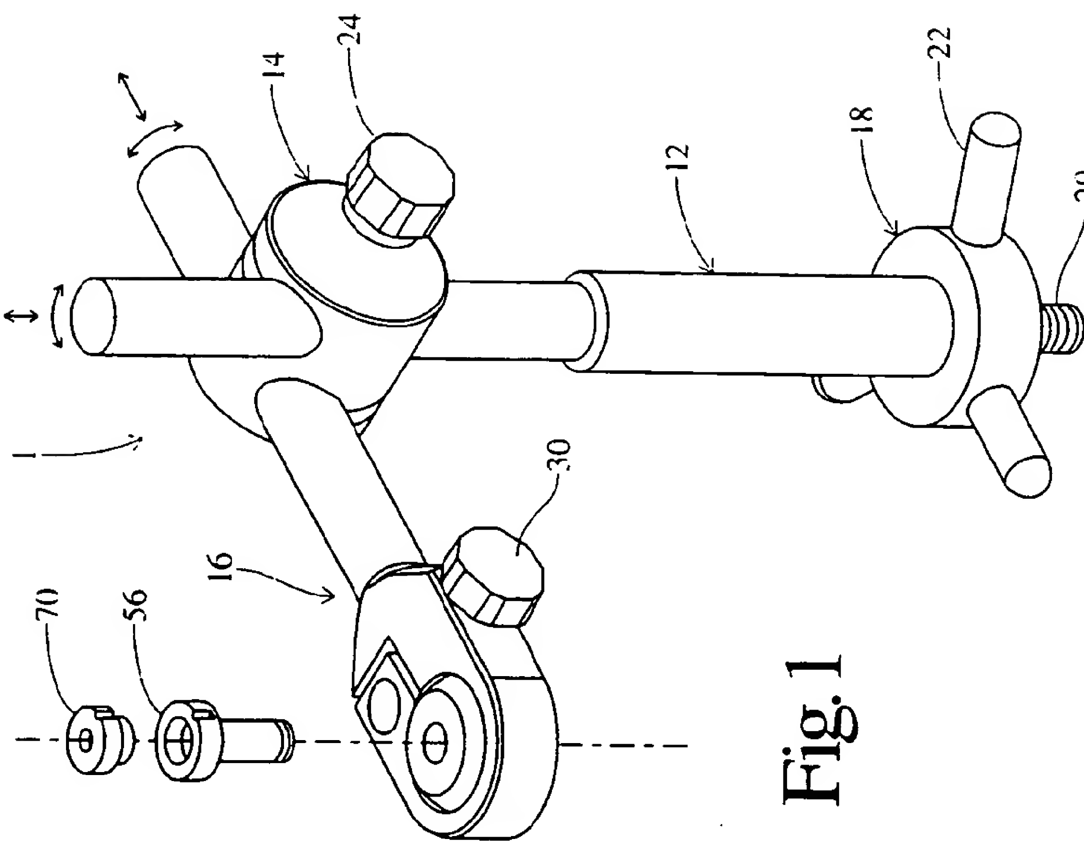


Fig. 1

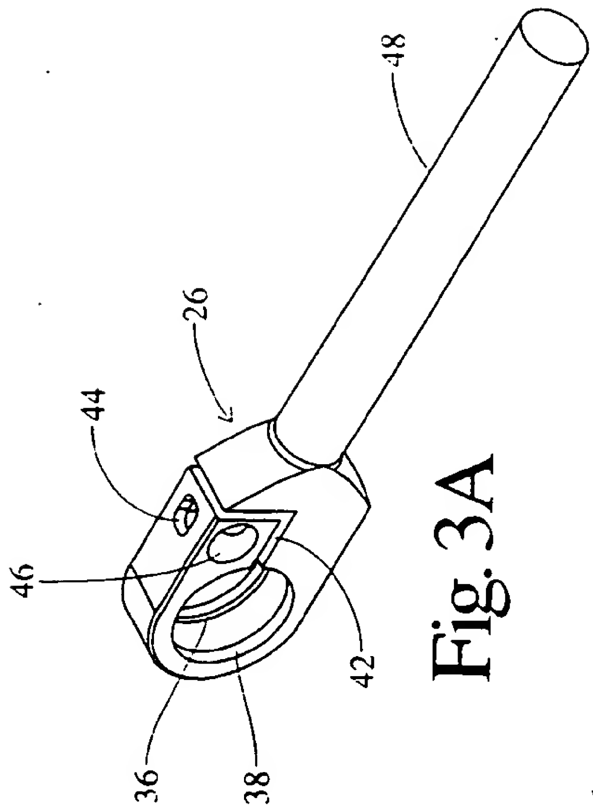


Fig. 3A

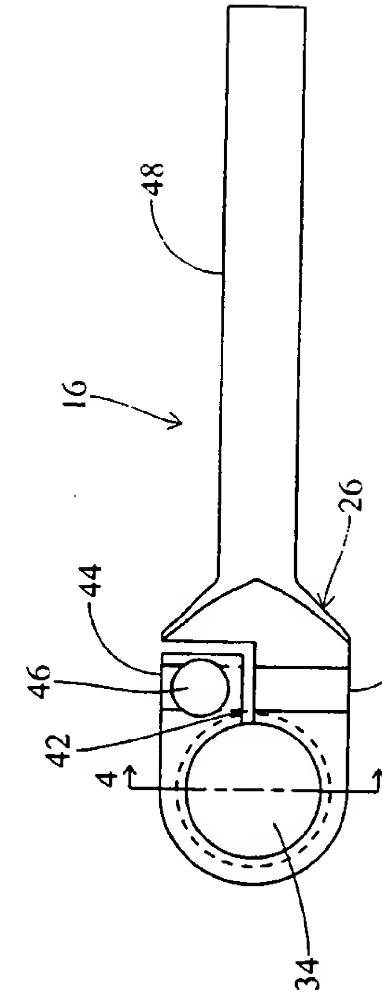


Fig. 3B

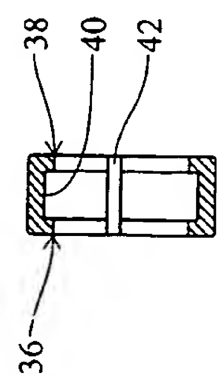


Fig. 4

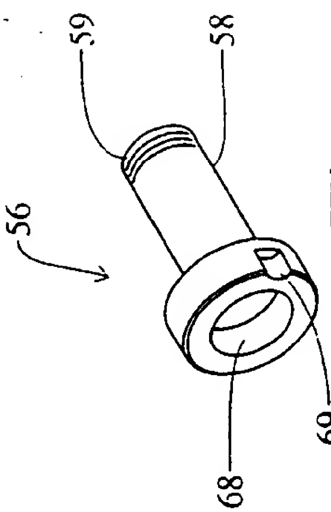


Fig. 7A

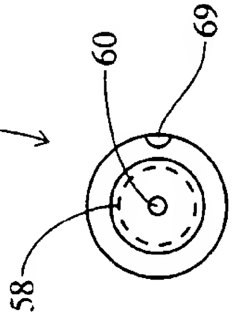


Fig. 7B

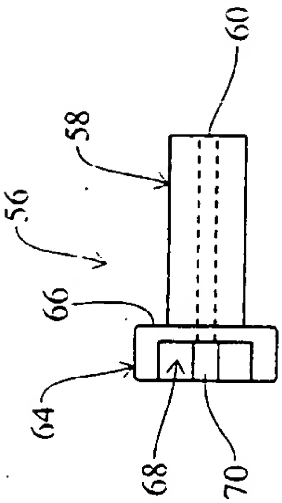


Fig. 7C

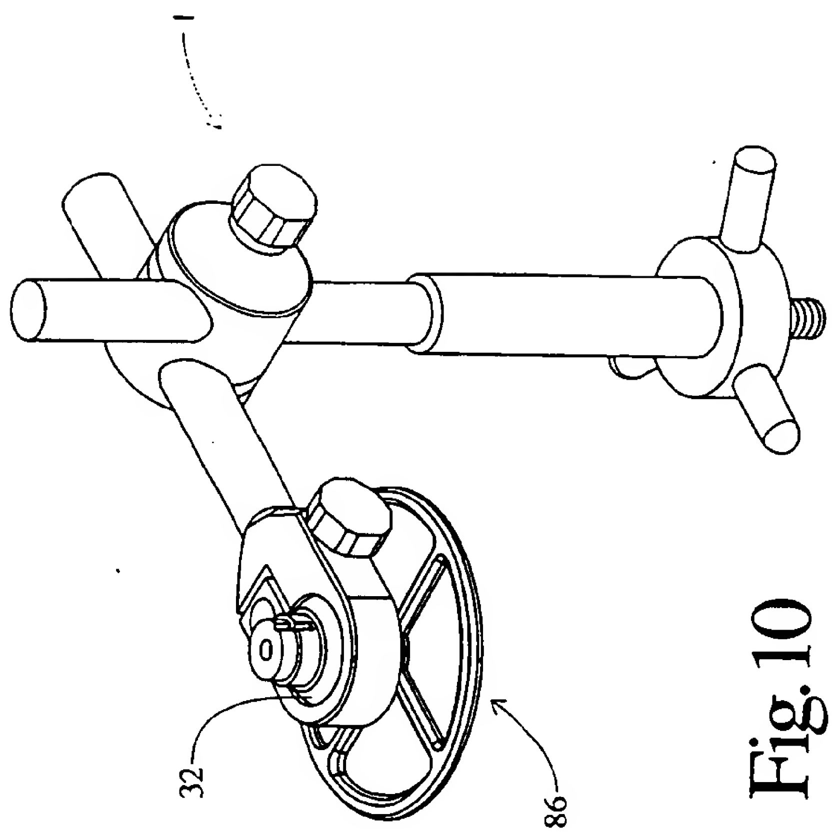


Fig. 10

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 904 741 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
06.09.2000 Bulletin 2000/36

(51) Int Cl.7: A61B 19/00, A61B 17/00

(43) Date of publication A2:
31.03.1999 Bulletin 1999/13

(21) Application number: 98306494.0

(22) Date of filing: 14.08.1998

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 26.09.1997 US 60103 P

(71) Applicant: PICKER INTERNATIONAL, INC.
Cleveland, Ohio 44143 (US)

(72) Inventors:
- Stern, Benjamin
Willoughby Hills, Ohio 44094 (US)
- Molyneaux, David
Mentor, Ohio 44060 (US)
- Lampman, David
Eastlake, Ohio 44095 (US)

(74) Representative: Waters, Jeffrey
Marconi Intellectual Property
Waterhouse Lane
Chelmsford Essex CM1 2QX (GB)

(54) **Apparatus for supporting a surgical instrument**

(57) An apparatus (1) for supporting a surgical instrument in the operative environment of an imaging device comprises components all made of a material compatible for use in the operative environment of the imaging device. The components of the apparatus (1), made of such a material, include a member (32) that has a spherical surface and includes a bore (50) extending through the member along its diameter. A grip (26) has a grip surface defining an aperture that is adapted to receive the member for rotatable movement within the aperture. The grip (26) extends around the member (32) in a circumferential path and has a gap therein. A fastener (30) is operatively connected to the grip (26). The fastener (30) is adjustable to change the size of the gap and adjust the compressive force applied to the received member (32) in the grip.

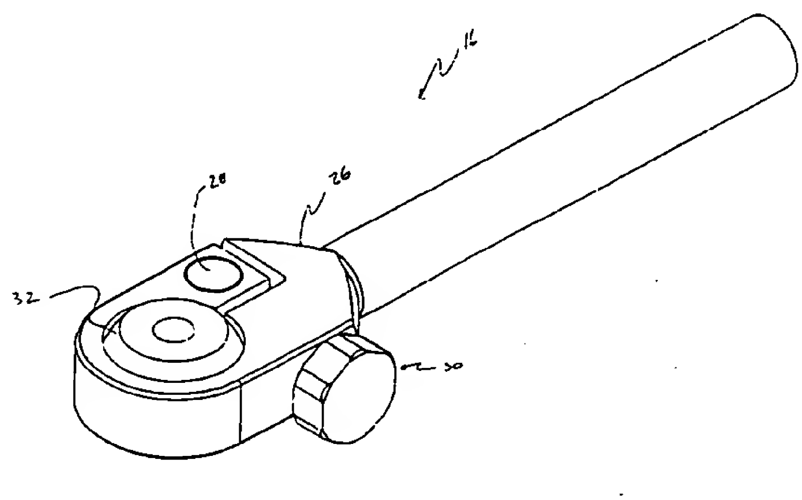


FIGURE 2

EP 0 904 741 A3

# ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 98 30 6494

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

18-07-2000

| Patent document cited in search report | | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|---|
| US 4981142 | A | 01-01-1991 | NONE | |
| US 4867404 | A | 19-09-1989 | NONE | |
| US 5595191 | A | 21-01-1997 | NONE | |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82